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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/523,491	03/10/2000	Jason W. Klaus	UTC 003/9035	4903

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EXAMINER	
FULLER, ERIC B	
ART UNIT	PAPER NUMBER
1762	

DATE MAILED: 08/13/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/523,491	KLAUS ET AL.	
	Examiner	Art Unit	
	Eric B Fuller	1762	

-- The MAILING DATE of this c mmunication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *10 June 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *7-10,13-17 and 20-34* is/are pending in the application.

4a) Of the above claim(s) *25-34* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *7-10,13-17 and 20-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Election/Restrictions

Applicant's election without traverse of Group I, claims 1-24, in Paper No. 12 is acknowledged.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 7, 8, 13-15, 17, 20, and 22 are rejected under 35 U.S.C. 102(e) as being anticipated by Kobayashi et al. (US 5,175,017).

Kobayashi teaches a process of depositing tungsten on a semiconductor substrate by flowing tungsten fluoride and silane into a CVD chamber with the substrate held at 300 degrees Celsius (column 4, lines 7-38). The Applicant's claims do not necessitate that the steps of contacting with a metal halide and contacting with a silane must be separate steps. Therefore, the claims, as written, read on the intermediate surface reactions (column 3, lines 35-45) that inherently occur when reducing tungsten fluoride with silane by the process taught by Kobayashi.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 7, 8, 13-17, and 20-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Izumi (US 5,306,666) in view of Bean (www.frii.com).

Izumi teaches a process of forming a thin metal film on a substrate (abstract). Sequentially flowing tungsten hexafluoride, then a reducing gas, produces the tungsten film (column 2, lines 41-51; column 1, lines 65-68). Additionally, it is taught that the substrate may be a semiconductor (column 10-25) and that the process is repeated until the desired thickness is achieved (figure 2). The surface of the metal comprises a metal-metal halide surface during repetitions of the process (figure 3). The reference teaches to use hydrogen as the reducing gas (column 2, lines 45-51), and in doing so fails to teach using silane as the reducing gas in the sequential CVD process. However, Bean teaches the pros and cons of using silane and/or hydrogen as reducing gases for tungsten fluoride. It is taught that silane is best used as the reducing gas for forming a "seed" layer, followed by using hydrogen as the reducing gas for the remainder of the deposition (abstract). This is because using hydrogen as the reducing gas allows for tungsten fluoride to attack substrates that do not have "seed" layers (page 4, 4th paragraph). Therefore, it would have been obvious at the time the invention was made to a person having ordinary skill in the art to utilize silane as the reducing gas for

depositing a "seed" layer in the process taught by Izumi. By doing so, the substrate is prevented from being attacked by the tungsten fluoride. The Applicant's claims read on forming this seed layer. Additionally, Bean teaches that when using silane as a reducing gas to form a "seed" layer, the substrate is held at 300 degrees Celsius (page 4, 2nd paragraph). To use this temperature would have been obvious with the expectation of success.

Claims 10 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Izumi (US 5,306,666) and Bean (www.frii.com), as applied to claims 7 and 17 above, in further view of Pogge (US 5,681,775).

Izumi, in view of Bean, teaches the limitations of claims 7 and 17. The references fail to teach that the substrate surface comprises hydroxide. However, Pogge teaches that it is well known to hydoxilate the surface of semiconductor wafers in order to increase bonding (column 7, lines 12-20). To do so would have been obvious in order to increase the bonding of the metal layer with the substrate.

Claims 9 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Izumi (US 5,306,666) in view of Bean (www.frii.com), as applied to claims 7 and 17 above, in further view of Pogge (US 5,681,775) and Humphery et al. (US 6,440,541 B1).

Izumi, in view of Bean, teaches the limitations of claims 7 and 17. The references fail to teach that the silylating agent is flowed first. However, it has been shown above that Pogge makes obvious the substrate surface comprising hydroxide.

Additionally, Humphrey teaches that silane may be used to increase the bonding between metals and hydroxides (column 3, lines 39-48). Therefore, it would have been obvious to flow silane onto the hydroxilated surface prior to the metal deposition step. By doing so, bonding is further increased.

Claims 7, 8, 13-17, and 20-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Leem (US 6,143,659) in view of Tsai et al. (462-IEDM 88).

Leem teaches a process of coating forming a metal layer on a semiconductor surface (abstract) for use as an interconnect (column 1, lines 14-17). The process is formed by flowing a metal source gas, then sequentially flowing a reducing gas (figure 4) and repeated until the desire thickness is achieved. The reducing gas may be silane (table 2). The metal source gas is an aluminum halide (column 2, lines 40-45), thus Leem fails to explicitly teach tungsten as the metal. However, Tsai teaches a process of depositing tungsten by reducing a metal halide for use as an interconnect (abstract). It would have been obvious at the time the invention was made to a person having ordinary skill in the art to use tungsten in place of aluminum in the process taught by Leem. By doing so, one would have a reasonable expectation of achieving similar results, as both aluminum and tungsten are used for interconnects and both are deposited by reducing metal halides.

Although the reference is silent to the deposition temperature, it would have been within the skill of one practicing in the art to determine what this temperature should be for the use of the tungsten halide through routine experimentation. By doing so, one

would be optimizing the deposition rate while minimizing damage to the substrate while also considering energy costs.

As to claims 13, 17, and 20-24, Leem fails to explicitly teach that the halide is fluoride. However, it is the position of the examiner that since there are only 5 halides possible, to choose fluoride as the halide would have been obvious absence evidence of criticality.

Claims 10 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Leem (US 6,143,659) in view of Tsai et al. (462-IEDM 88), as applied to claims 7 and 17 above, in further view of Pogge (US 5,681,775).

Leem, in view of Tsai, teaches the limitations of claims 7 and 17. The references fail to teach that the substrate surface comprises hydroxide. However, Pogge teaches that it is well known to hydoxilate the surface of semiconductor wafers in order to increase bonding (column 7, lines 12-20). To do so would have been obvious in order to increase the bonding of the metal layer with the substrate.

Claims 9 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Leem (US 6,143,659) in view of Tsai et al. (462-IEDM 88), as applied to claims 7 and 17 above, in further view of Pogge (US 5,681,775) and Humphery et al. (US 6,440,541 B1).

Leem, in view of Tsai, teaches the limitations of claims 7 and 17. The references fail to teach that the silylating agent is flowed first. However, it has been shown above that Pogge makes obvious the substrate surface comprising hydroxide. Additionally,

Humphrey teaches that silane may be used to increase the bonding between metals and hydroxides (column 3, lines 39-48). Therefore, it would have been obvious to flow silane onto the hydroxilated surface prior to the metal deposition step. By doing so, bonding is further increased.

Claims 7-9, 13-17, and 20-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsai et al. (462-IEDM 88) in view of Srinivasan et al. (US 6,040,010) and Kobayashi et al. (US 5,175,017).

Tsai teaches depositing tungsten layers by tungsten fluoride (column 2, line 3). During deposition, the metal deposition is interrupted to deposit poly-silicon, which is consumed by further deposition of tungsten. Poly-silicon may be the first layer deposited thus rendering the process independent of the substrate (column 3, 3rd paragraph). The surface compositions of each step are inherent to the process. The reference is silent to the deposition temperatures.

However, Srinivasan teaches to deposit poly-silicon layers by decomposing silane at temperatures below 300 degrees Celsius. Therefore, to use this process to deposit the poly-silicon of Tsai would have been obvious at the time the invention was made to a person having ordinary skill in the art. By doing so one would have a reasonable expectation of success as Tsai teaches the desire to deposit poly-silicon and Srinvasan teaches how this is done.

Additionally, Kobayashi teaches to deposit tungsten by reducing tungsten fluoride at 300 degrees Celsius. To use this temperature would have been obvious at the time

the invention was made to a person having ordinary skill in the art. By doing so, one would have a reasonable expectation of success as Tsai teaches to deposit tungsten by reducing tungsten fluoride and Kobayashi teaches temperatures that this is typically done at.

Claims 10 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsai et al. (462-IEDM 88) in view of Srinivasan (US 6,040,010) and Kobayashi (US 5,175,017), as applied to claims 7 and 17 above, in further view of Pogge (US 5,681,775).

Tsai, in view of Srinivasan and Kobayashi, teaches the limitations of claims 7 and 17. The references fail to teach that the substrate surface comprises hydroxide. However, Pogge teaches that it is well known to hydoxilate the surface of semiconductor wafers in order to increase bonding (column 7, lines 12-20). To do so would have been obvious in order to increase the bonding of the metal layer with the substrate.

Response to Arguments

Applicant argues that Leem only teaches aluminum and thus fails to read on the claims as amended. Examiner agrees and has combined Leem with Tsai in order to make up for this deficiency. Applicant's arguments are moot in view of the new grounds of rejection.

Applicant argues that Izumi teaches away from the claimed invention when it is taught to use hydrogen over silane as the reducing agent. In regards to Izumi in view of Bean, this argument is not found convincing. Izumi teaches to use hydrogen because silane may cause contamination in the film. Bean teaches the benefits of using silane as the reducing gas in forming a seed layer, as hydrogen may allow for the tungsten halide to attack the substrate. Izumi may teach away from using silane for depositing the bulk metal layer, but does not teach away from this additional seed layer that is deposited by silane prior to the bulk layer. This seed layer provides benefits as shown above and reads on the applicant's claims as amended.

All other arguments are moot in view of the new grounds of rejection.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Berenbaum et al. (US 6,066,366) is cited as being pertinent to the applicant's disclosure.

Applicant's amendment necessitated the new grounds of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not

mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eric B Fuller whose telephone number is (703) 308-6544. The examiner can normally be reached on Mondays through Thursdays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive Beck, can be reached at (703) 308-2333. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

EBF
August 6, 2003

TIMOTHY MEEKS
PRIMARY EXAMINER